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Young et al.

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[54] **APPARATUS AND BRUSH SEGMENT ARRANGEMENT FOR FINISHING WHEEL BRUSHES**

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[73] Assignee: **Minnesota Mining and Manufacturing Co.,** St. Paul, Minn.

[21] Appl. No.: **863,383**

[22] Filed: **Apr. 3, 1992**

Related U.S. Application Data

[63] Continuation of Ser. No. 606,533, Oct. 31, 1990, abandoned, which is a continuation-in-part of Ser. No. 477,192, Feb. 5, 1990, Pat. No. 5,016,311, which is a continuation of Ser. No. 186,907, Apr. 27, 1988, abandoned.

[51] **Int. Cl.**[5] **A46B 13/02**

[52] **U.S. Cl.** **15/179;** 15/183; 15/217; 15/230.14; 15/230.16; 15/230.19; 51/364; 492/29; 492/36

[58] **Field of Search** 15/88.3, 176.1, 176.6, 15/179–183, 186–188, 215–217, 230.13, 230.14, 230.16, 230.19, 238; 29/120, 121.1, 124, 127; 51/364–366, 334, 358; 101/415.1, 377

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FIG. 1—Crimp Channel Brushes.
FIG. 2—Multiple Crimp Channel Wheels.
FIG. 3—Crimp Channel Strips in a Slotted Hub.

(List continued on next page.)

Primary Examiner—Harvey C. Hornsby
Assistant Examiner—Mark Spisch
Attorney, Agent, or Firm—Merchant, Gould, Smith, Edell, Welter & Schmidt

[57] **ABSTRACT**

A brush segment for mounting on a slotted support structure is presented. The brush segment generally comprises: a substrate; a carpet of bristles mounted on the substrate in a preferred manner; and, a root system projecting outwardly from a side of the substrate opposite from the carpet of bristles. Brush segments according to the present invention are particularly well-adapted for mounting in association with longitudinal slots of a cylindrical hub arrangement, including conventional cylindrical hub arrangements. In preferred applications the substrate is formed from a pliable material which is then hardened in a preferred configuration.

10 Claims, 4 Drawing Sheets

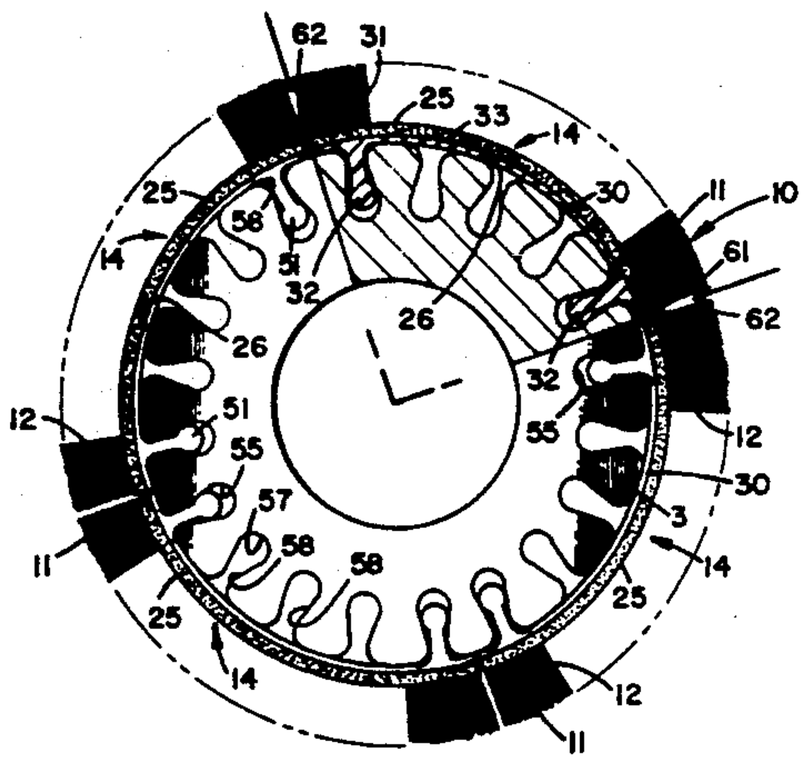

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FIG. 4—3M Brushlon ® Brand Material, 3M Company.

FIG. 5—3M Brushlon ® Brand Material, 3M Company.

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FIG. 6—Elongated Abrasive Bristles Mounted in a Metal Root.

FIG. 7—Elongated Abrasive Bristles Mounted in a Metal Root.

FIG. 8—Elongated Abrasive Bristles Mounted in a Metal Root.

FIG. 9—3M Long Trim Brush-Segments in a Slotted Hub.

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FIG. 10—Finishing Apparatus with Abrasive Flaps.

FIG. 11—Various 3M Hubs, 3M Company.

FIG. 12—Non-woven Abrasive Material Between Abrasive Flaps in a Fabric Root.

Royalcast catastable plastics.

FIG. 1

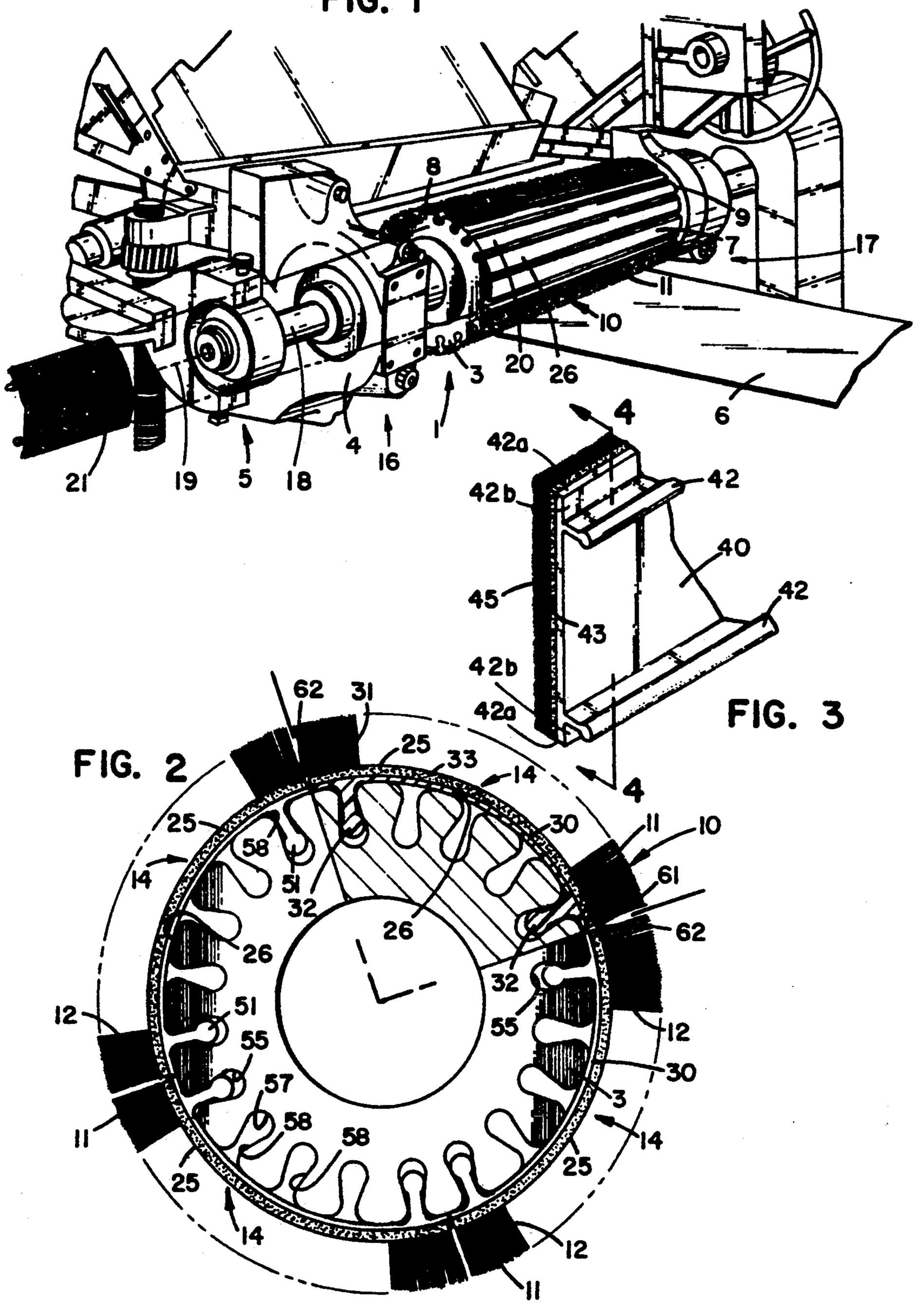
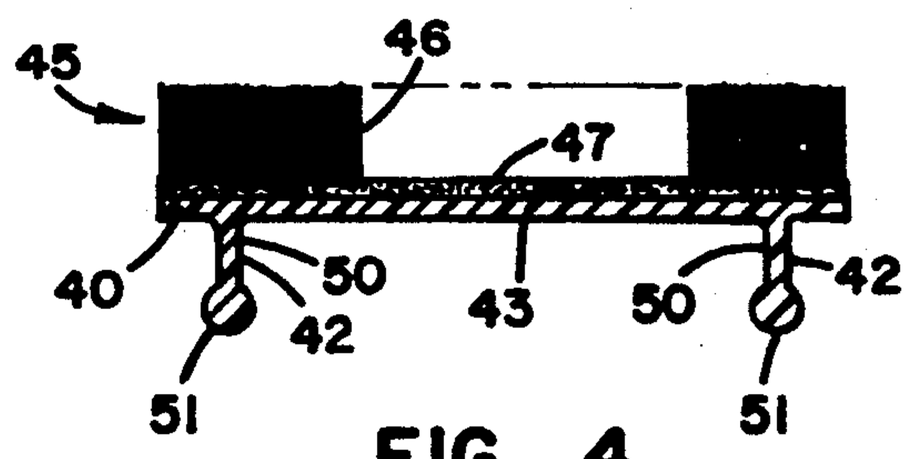


FIG. 3

FIG. 2



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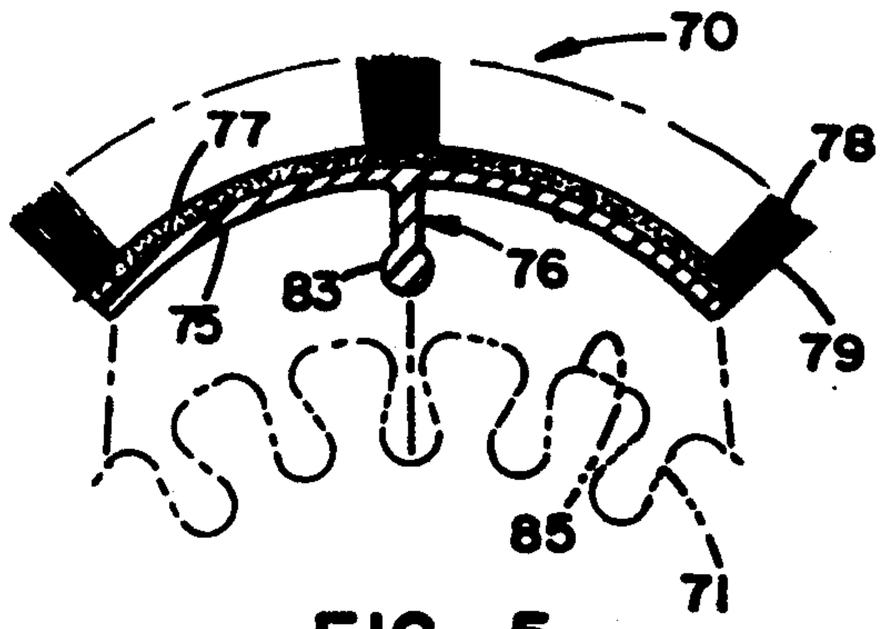

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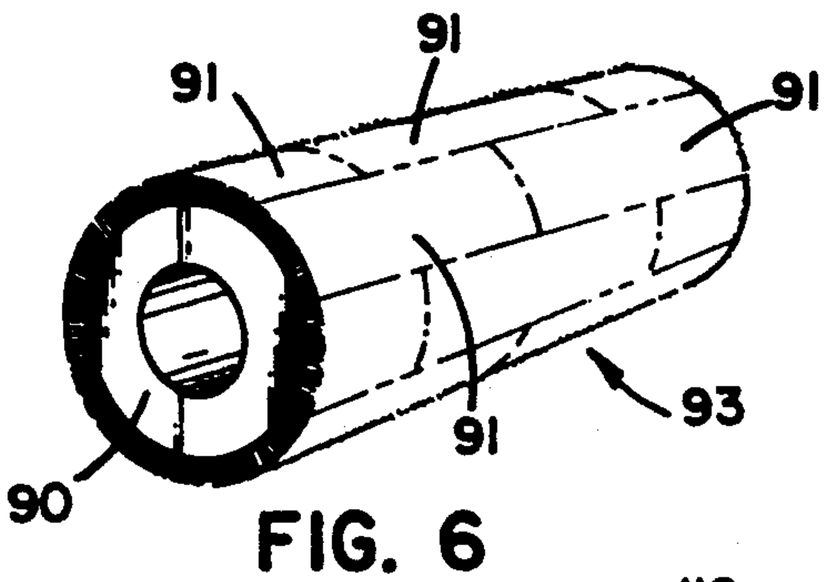

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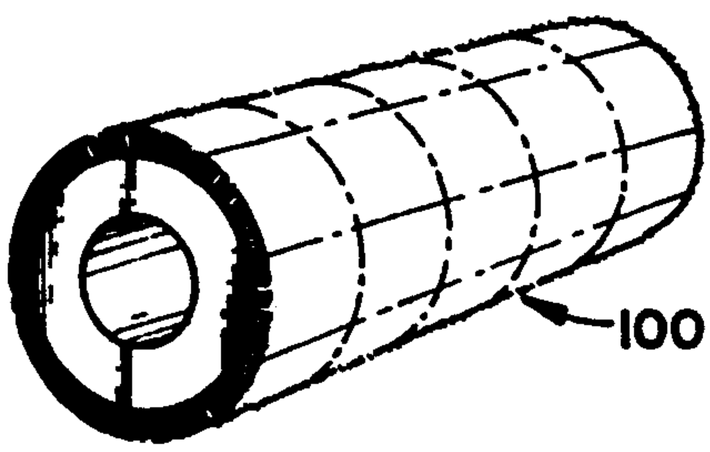


FIG. 7

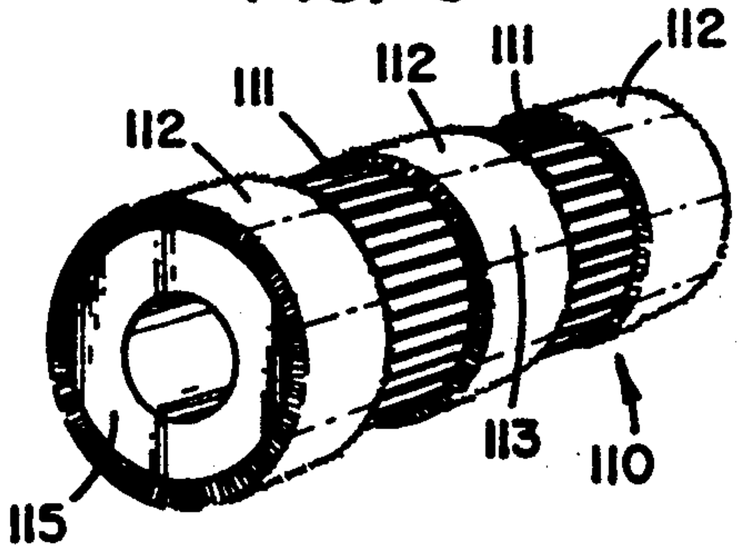


FIG. 8

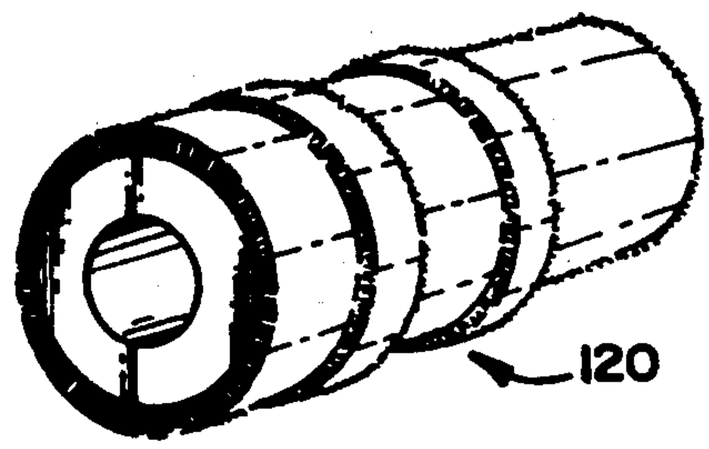
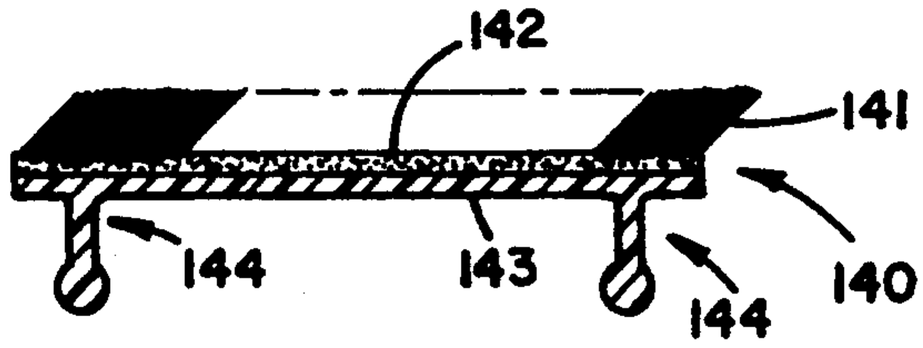


FIG. 9



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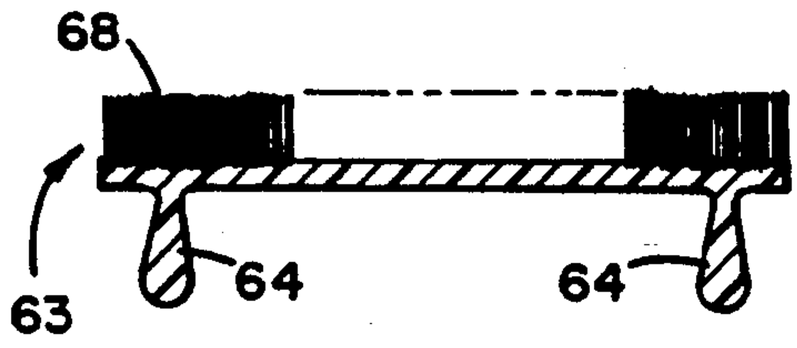

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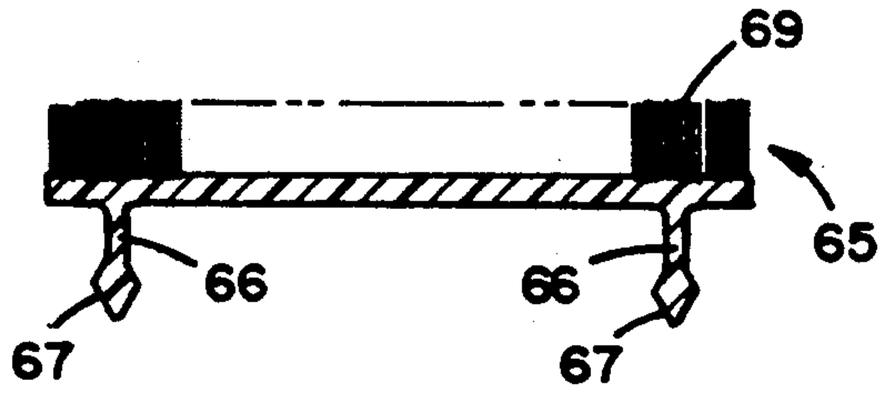
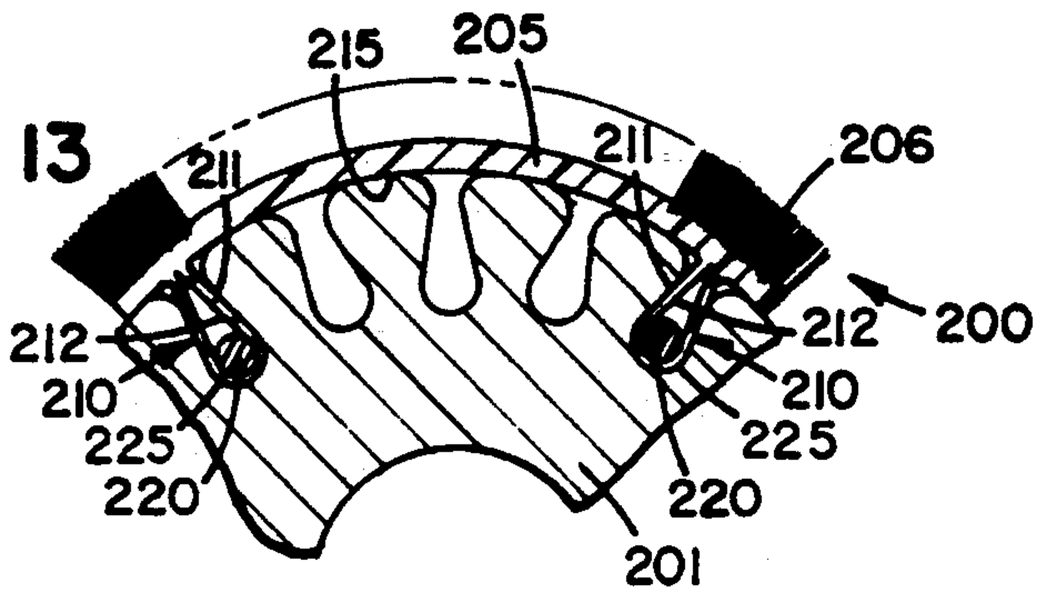


FIG. 12

FIG. 13



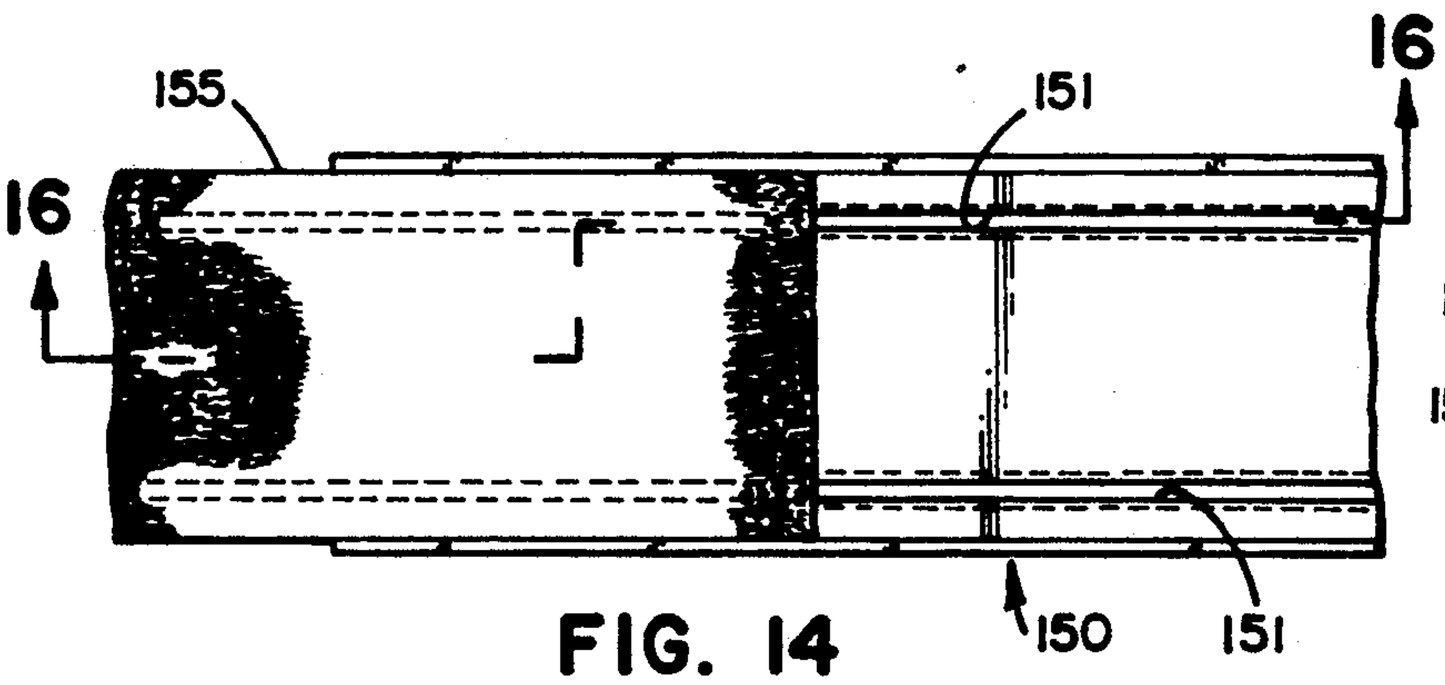


FIG. 14

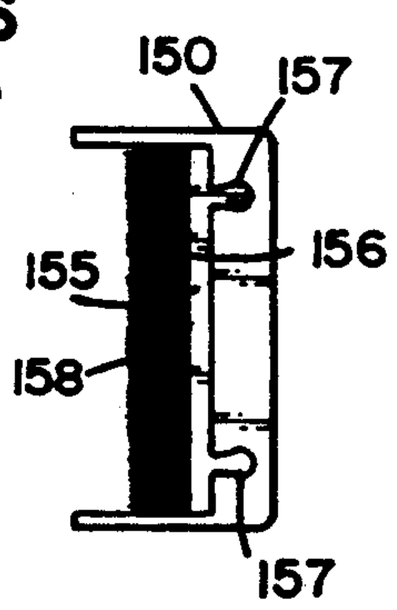


FIG. 15

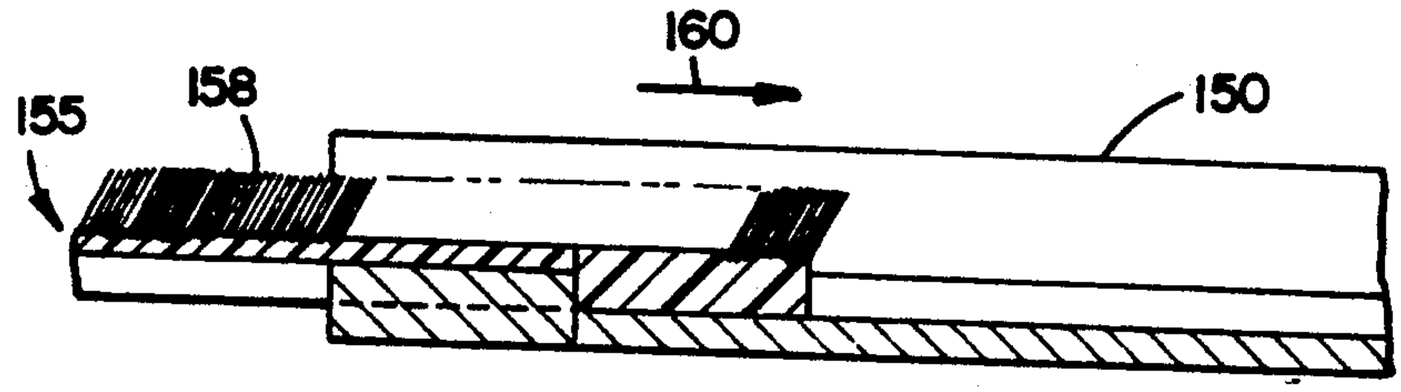


FIG. 16

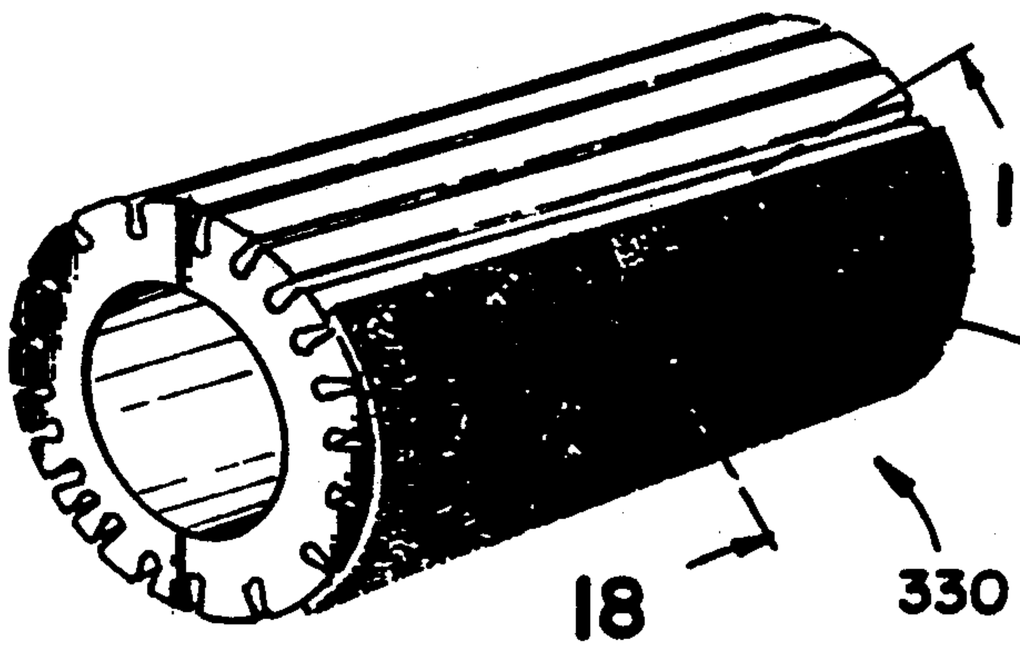


FIG. 17

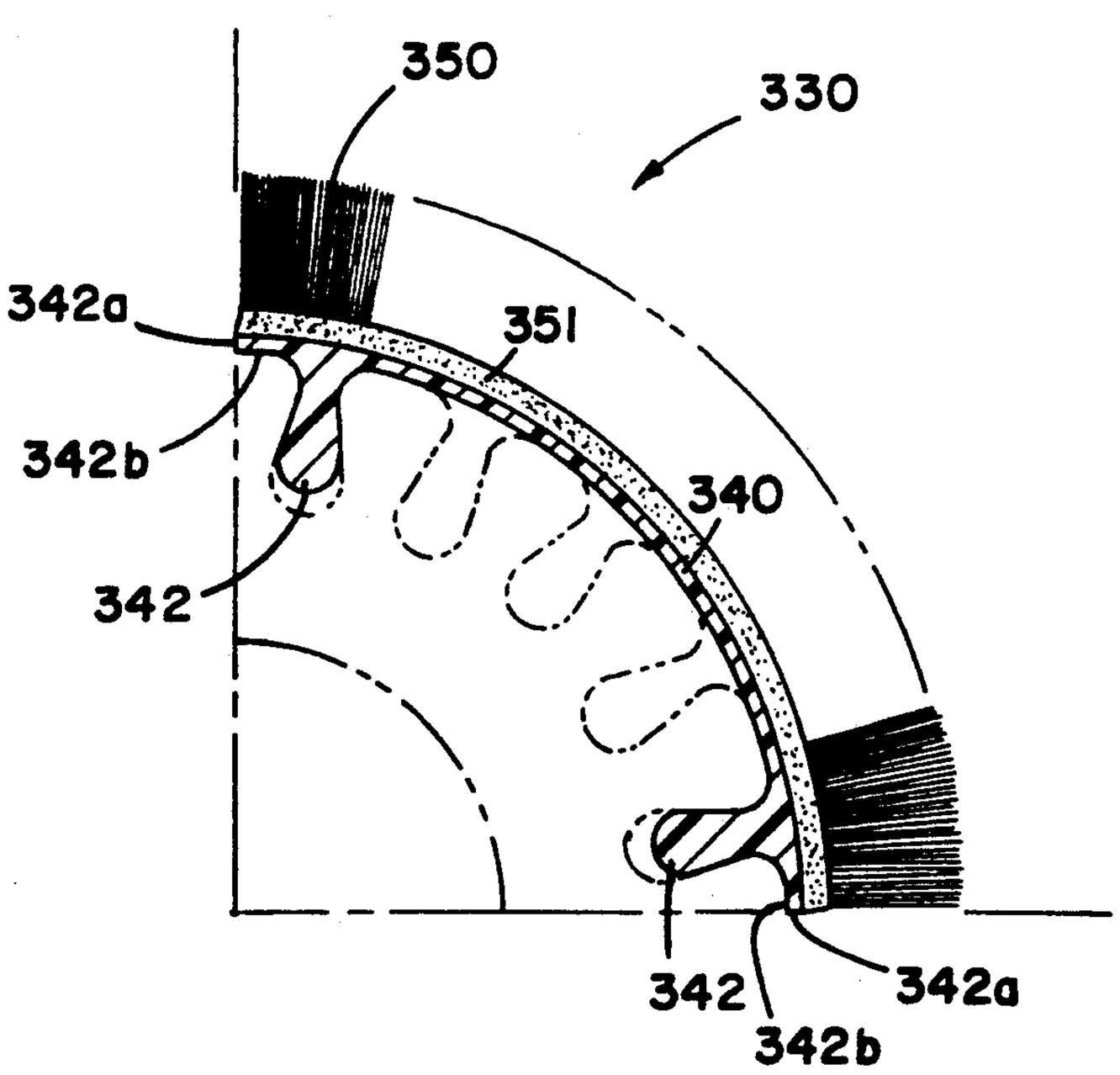


FIG. 18

APPARATUS AND BRUSH SEGMENT ARRANGEMENT FOR FINISHING WHEEL BRUSHES

CROSS-REFERENCE TO RELATED APPLICATION

The present application is a continuation of U.S. Ser. No. 07/606,533, filed Oct. 31, 1990, abandoned, which was a continuation-in-part of U.S. Ser. No. 07/477,192, filed Feb. 5, 1990, U.S. Pat. No. 5,016,311. Application Ser. No. 07/477,192 was a continuation of U.S. Ser. No. 07/186,907, filed Apr. 27, 1988, abandoned. U.S. Ser. No. 07/186,907 is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention concerns industrial brushes, and in particular arrangements for mounting such brushes in association with a carrier substrate. The preferred embodiment concerns finishing wheels having removable and replaceable brush segments thereon.

BACKGROUND OF THE INVENTION

In many industries, abrasive brushes are used to prepare and/or to finish materials. Brushes have been applied, for example, to: generate satin finishing of metal; deburr metal products; finish wood materials; conduct flash removal from plastics; facilitate oxide removal from metallic materials; and, to clean and/or etch glass. To accomplish these, and other applications, industrial brushes have been provided with a variety of types of bristles including bristles made from: polyesters, polyethylene, nylon and polypropylene strands or fibers. The bristle material may, optionally, be impregnated with abrasive materials. The various types of fibers have found use in a wide variety of applications, to obtain varying effects in surface treatment of articles brought into association with the brush.

For many industrial applications, the brushes are mounted on wheels or rollers which are rapidly spun during a finishing operation. In a typical industrial application, an elongate cylindrical roller having brush material mounted thereon is provided. Material to be treated is then passed along a conveyed path and into engagement with the brush media.

A major concern of the finishing products industry has been the development of convenient, effective, methods for the mounting of brush elements, i.e. fibrous or bristle material, onto industrial finishing rollers, wheels or the like. Other major concerns in the industry have involved the nature of the fibre or bristle mounting within the brush element.

As to brush bristle mounting, many industrial brushes are of one of three types: crimped channel construction; tufted construction; and, products in which individual bristles are mounted tightly packed but spaced independently and not in either tufts or crimped channels, i.e, the bristles form a carpet-like arrangement of individually mounted bristles.

Crimp channel brushes are generally made by securing the base end of the bristles in a metal channel. The channel is usually formed in such a manner that the bristles are held fast, when sides of the channel are forced together or crimped. In some constructions, the bristles are individual strands held in the channel. However, often the bristles are folded in half, and the bent loops are mounted in the channel.

Tufted brushes are very common in both industrial and consumer applications. Tufted brushes are characterized by an anchoring of a group of bristles (the tuft) in a hole or other receptacle in a base material. The tuft is then secured within the receptacle by: heat-bonding; an adhesive; stapling; stitching; or, by some other, similar, means. The size and shape of a tufted brush is defined generally by the design of the base or substrate to which the tufts are attached. The distribution of brush media is determined by the pattern of receptacles in the base, and the number of bristles in each tuft. Such media can be arranged to form a carpet-like bed of bristles.

The third general type of industrial brush comprises a construction wherein bristles are anchored individually, rather than in groups or bunches. Typically, the bristles are anchored in a flexible base that allows the brush media to conform to a variety of configurations. A particularly well-known example of this type of brush is the Brushlon ® line of products (3M, St. Paul, Minn. 55144). Such brushes involve anchoring of bristles in a polymeric bed (resin) either applied to or including a substrate. Such systems form a thick carpet-like bed of bristles. In some applications, the bristles may be directly set in the substrate.

For many industrial applications, the third type of arrangement (individually mounted bristles) is preferred. Reasons include the fact that the construction generally avoids gaps between fibers, which could clog with collected particles. Further, individual bristles are less likely to break, due to good support provided by adjacent bristles or fibers. Also, since the fibers are spread relatively evenly across the work surface, each fibre or bristle, in a localized region, is more likely to be worked to approximately the same extent as other bristles. Thus, such arrangements wear relatively well.

A variety of methods have been utilized for the attachment of brush materials to substrates such as finishing wheels. For example, strips of crimp channel brush material have been constructed such that they can be mounted on a cylinder, for use in a grinding operation. Tufted brushes have frequently involved a permanent mounting of tufts, in a substrate device adapted for mounting as a wheel or the like, for a finishing operation. Individually set bristle products, such as Brushlon ® products, have been provided on flexible backing, attachable by a variety of means, including hook and loop mounting means (such as Velcro ®), to wheel cylinders etc. for use.

Products other than brushes have been utilized for surface finishing operations, on various materials. These include abrasive flap-wheel arrangements having flaps formed from extensions of fibrous non-woven abrasive material such as Scotchbrite ® abrasive material (3M, St. Paul, Minn. 55144) and elongate sacrificial fibre products. Other finishing devices include grinding wheels, and coated abrasive products such as sandpaper or the like. For any of these three types of arrangements, generally the abrasive material is sacrificed during use, with a final discarding of an associated core or substrate. It is noted that abrasive flap wheels frequently involve rather elongate paddle-like flaps of material, which during rotation of a associated hub, are spun into association with a substrate to be treated.

It is desirable to provide abrasive finishing arrangements (industrial) wherein the abrasive material can be relatively easily removed or replaced. For non-brush abrasive arrangements, this could generally be accommodated by having a mounting system whereby exten-

sions or flaps of abrasive material can be easily removed and replaced. For brush arrangements, the nature of mounting and the ease with which replacement can be obtained has, generally, depended upon the nature or classification of brush involved.

Crimp channel brush media has been made available in spiral form, so that it can be mounted to a reusable hub by wrapping the brush tightly around the hub and clamping down ends of the brush.

As previously indicated, arrangements utilizing individual bristles mounted spaced from one another to a flexible substrate have also been provided in removable, replaceable, forms. Most notably, for example, the 3M Brushlon ® product has been provided with a hook and loop mounting system in association therewith, for attachment to wheels or rollers also having hook and loop attachment means thereon. For example, in forming a roll or cylinder brush, an elongate strip of 3M Brushlon ® material might be wrapped spirally about the cylinder.

Non-woven abrasive products are also available in belt form, and have been mounted on expanding rubber wheels or the like. Also, hook and loop mounting systems have been utilized for such products, although generally they have involved mounting on flat surfaces rather than cylinders. Reusable hubs have been used with non-woven abrasive materials, by mounting a series of doughnut-shaped pieces onto a hub with clamping at ends.

One problem with mounting methods that have involved winding of brush material about a hub or the like, is that a considerable length of time, and care, may be needed in order to achieve effective, proper, placement and alignment of brush bristles. For example, in applying 3M Brushlon ® stripping to a roller, substantial down time to the roller device may be necessary while the spiral mounting is accomplished. In some instances, it may even be necessary to remove the roller from the brush equipment, in order to obtain replacement. Similar problems would prevail with many spirally mounted arrangements regardless of the type of brush media involved.

Another problem with spirally wound systems, is that ends of the narrow strands present problems, or weak points, for attachment. Thus, in some instances special anchoring may be necessary at the very ends of the narrow strips; for example, 3M Brushlon ® strips are generally anchored by bolts or the like, at opposite ends. These anchors can provide significant problems for several reasons: first, the anchors may generate a small bald spot in a brush. Secondly, setting of the anchors may require special tools or equipment. Further, the anchors may generate a weak spot, or flaw, in the brush substrate.

For some abrasive cylinder applications, slotted hubs have been developed. An example of such a slotted hub is the 3M RX hub. Slotted hubs will be described in further detail below, with respect to a detailed description of the invention. In general, slotted hubs comprise an elongate cylinder having a plurality of longitudinal slots around the outer surface of the cylinder. Each slot is sized and oriented for anchoring of material thereto. Preferably each slot is provided in communication with at least one end surface of the cylinder hub, for ease of mounting. Although a variety of arrangements may be utilized, in general in accord with industry standards and general agreement, about five slots per inch outside diameter have been frequently used. However, there is considerable industry variation.

Crimped channel or strip brushes are sometimes mounted in slotted hubs. In general, the crimp or strip, having bristles extending therefrom, is slid, longitudinally, into one of the cylinder channels and is retained therein. Retention is frequently accomplished through use of a channel having a wide internal portion and a narrow neck; with the brush material being anchored in a relatively wide root of material. The brush material can be slid longitudinally into the slot, with radial separation from the hub being basically impossible due to interference, but with longitudinal separation being relatively simple to achieve.

The common type of finishing wheel arrangement using a slotted hub, is one wherein the replaceable segments comprise abrasive flap segments. Each group of abrasive flaps is generally mounted to a root, which is anchored to the slotted hub. Examples of these include products marketed by 3M under the designations RX and RXC. RX segments contain coated abrasive flaps and RXC segments contain non-woven Scotchbrite ® abrasive material, as well as coated abrasive flaps.

In many conventional applications of longitudinal slotted hubs, each abrasive member is mounted on a single root. The abrasive members are such that each abrasive member/root combination is capable of a certain amount of hinged movement, or pivoting movement, (i.e. flapping) with respect to the hub itself.

What has been needed has been a method and arrangement whereby a brush arrangement comprising a carpet-like arrangement of bristles, i.e. tufted or preferably individually anchored bristle arrangements, can be securely mounted in a slotted arrangement, for use as a cylindrical brush or the like. What has been particularly needed has been an arrangement whereby mounting, removal and replacement of brush material may be rather readily effected.

SUMMARY OF THE INVENTION

According to the present invention a brush segment for mounting on a slotted support structure is provided. The slotted support structure may be of a variety of types including: cylindrical hub arrangements, such as the conventional cylindrical hub arrangement available from 3M as an RX hub; and, flat, slotted, support structures provided in a vibrating table arrangement or the like. In general, the brush segments comprise: a substrate having first and second opposite surfaces; a carpet of bristles mounted on the substrate to extend outwardly from the substrate first surface; and, a root system extending outwardly from the substrate second surface, the root system being constructed and arranged to mount the substrate to the slotted support structure by engagement with at least one slot thereof. Means are provided in the brush segment to inhibit flapping or rocking movement even with a curved, conventional, hub such as an RX cylindrical hub. That is, each brush segment includes means thereon which ensures that the segment, when mounted on a slotted support, including even a conventional cylindrical support, will not rock, flap, tip or wobble substantially, relative to the support. This securing means is described in further detail below.

Preferably, the carpet of bristles comprises a plurality of spaced, independently-mounted bristles. Herein the terms "carpet", "carpet-like" or variants thereof are meant to refer to an arrangement of bristles having an outer surface with substantial extension in two direc-

tions. That is, a "carpet" of bristles is more than a mere row of tufts or individually mounted bristles. Rather, the surface of the carpet exhibits substantial extension not only in length, but also width. A carpet of bristles may be formed, for example, from a plurality of substantially parallel rows of bristles or tufts of bristles, or it may be formed from randomly mounted bristles on a surface.

In one preferred embodiment, the substrate comprises a flat, elastic, rectangularly cross-sectioned, extension of material; and, the root system comprises a plurality of spaced, elongate, substantially parallel root members, each having a relatively broad head portion and a relatively narrow neck portion. Preferably, the root system is unitary, or integral, with the substrate. For the preferred embodiment shown, preferably the plurality of root members comprise two root members spaced from one another and oriented to extend along, adjacent, and spaced from, opposite side edges of the substrate.

In an alternate embodiment, preferably the substrate is a relatively rigid, but elastic, member having a convex side and a concave side, with the bristles extending outwardly from the convex side; and, with the root system extending generally outwardly from the concave side; the curvature of the concave side being generally perpendicular to an extension of the root system. Such an arrangement is particularly well-adapted for mounting in association with a cylindrical hub. In one application, the concave side of the substrate has a first radius of curvature and the outer surface of the cylindrical hub has a second radius of curvature; the second radius of curvature being slightly larger than the first radius of curvature. As a result, the substrate will be snugly held against the cylindrical hub outer surface, when it is mounted thereon. For one such embodiment, the root system comprises a single elongate root member, mounted on, or extending (projecting) outwardly from, the concave side of the substrate.

In preferred embodiments described and shown, each root member comprises a relatively rigid extension. In an alternate embodiment, each root member comprises an elongate sleeve expandable upon insertion of a rod member or expansion member therein.

Also, according to the invention a combination comprising a cylindrical hub and at least one brush segment is provided. The brush segment may be as described herein. In general, the cylindrical hub has an outer surface with a plurality of spaced, longitudinal, slots therein. Each slot generally includes a wide recessed or head-receiving area, and, also, a relatively narrow neck portion which extends between the recessed area or volume and an outer surface of the hub. The slots are oriented to receive therein, longitudinally, portions of a brush segment or plurality of brush segments as previously described. In such a combination, the cylindrical hub may be a conventional cylindrical hub such as a 3M RX hub.

Also according to the present invention, when a plurality of brush segments are utilized to form a carpet of bristles around the outside of a cylindrical hub, a variety of advantageous arrangements may be provided. For example, segments, at least two of which have bristles of different construction, i.e. abrasiveness, length, strength, density, or direction of extension, may be used. Further, gaps in the outer brush surface can be selectively provided.

Also according to the present invention a method is described, for providing a brush surface on a cylindrical hub. Generally, the method comprises providing a cylindrical hub as previously described, and providing at least one brush segment as previously described. The brush segment is mounted on the cylindrical hub, according to the invention, by longitudinal insertion of a root system of the segment into a longitudinal slot formation of the hub.

In alternate embodiments the slotted support structure comprises an elongate relatively flat vibrating table with slots therein. Brush segments according to the present invention can be mounted in such an arrangement, for use in treating the surface and materials passing along the vibrating table.

In certain preferred applications to the present invention the brush segment comprises: a substrate; a carpet of bristles; and, a root system generally as described previously, except that the substrate is pliable in a first state and rigid in a second. In preferred applications, the substrate is a thermoplastic substrate pliable, i.e. flexible or moldable, when heated to a softening point, and relatively rigid when cooled. Preferably such thermoplastic substrates would be rigid up to at least a temperature of about 70° C., and pliable upon exposure to heat preferably somewhere in the range 90° C.–150° C. It will be understood that by the statement "pliable upon exposure to heat preferably somewhere within the range 90° C.–150° C., 90° C. or greater" it is not meant that the structure is necessarily rigid at all temperatures below, as long as it is rigid at a temperature of 70° C.

A reason why it is preferred that the thermoplastic substrates are rigid up to at least a temperature of about 70° C., is in order to ensure that they do not inappropriately soften under heat generated by friction build-up, when used on an industrial cylinder brush finishing device. It is foreseen that in general, for typical applications, an arrangement which maintains rigidity up to at least about 70° C., will be appropriate.

Herein what is said that the substrate is "thermoplastiç", it is not meant that the substrate cannot comprise a thermoset resin. As long as the thermoset resin exhibits thermoplastic properties, i.e. becomes flexible, upon heating to an appropriate temperature (softening point), it may be utilized as a "thermoplastic" substrate according to the present invention.

In general, the definition of pliability upon exposure to heat of 90° C. or greater, is selected for convenience. Heating an arrangement to a temperature of about 90° C.–150° C. can be readily accomplished, without excessive use of heat and/or unusual oven equipment. Thus, the arrangement can be readily heated to pliability (softening), adjusted fit a slotted mounting arrangement, and then cooled to rigidity.

It is noted that in some applications of the present invention a thermoset material may be utilized in a manner such that the substrate is formed while the thermoset material is not a completely cured resin. The partially cured (but pliable) substrate would then be molded to the hub, and then would be completely cured, for example upon heat treatment in an oven. Via this approach, as well as the former, it is foreseen that custom molded substrates according to the present invention can be readily prepared.

Brush segments according to the descriptions of the previous paragraphs involving pliability in one state and rigidity in another, may include features as generally described above with respect to other embodiments, for example a root system comprising a single elongate root member, or a plurality of spaced elongate substantially

parallel root members. Preferably (if for use on a slotted hub support structure) the substrate is generally curved in cross-section and comprises a curved extension of material having an elongate convex side and an opposite elongate concave side; the concave side corresponding to one of two opposite surfaces of the substrate and defining an arc of extension of at least about 6° preferably about 30° to 180°, and most preferably no greater than about 120°. Preferably in such constructions the carpet bristles comprises a plurality of individual bristles each of which extends perpendicularly to a plane of a surface of the substrate whereat that bristle is mounted. It will be understood that, however, in this embodiment variations as previously discussed may be utilized.

It is noted that when, according to the present invention, a substrate is described as flexible or pliable in a first state and rigid in a second, it is not meant that the system is necessarily capable of multiple cycling between the two states. It is enough if the substrate can be once rendered pliable, and later rendered rigid, after molding for some advantage. Although, in certain applications, further advantage is provided by allowing reconversion to a pliable state, after rigidity.

With respect to the latter described technology, involving pliable substrates, a method of preparing a brush segment for mounting on a cylindrical roller, i.e. the roller of an industrial cylinder brush finishing device, is suggested. The method comprises mounting a pliable brush segment on a slotted support structure, and then hardening the pliable brush segment. The slotted support structure may be the cylindrical roller of an industrial cylindrical brush finishing device; however, there is no requirement that it be so. When the method is practiced on the cylindrical hub of an industrial cylindrical brush finishing device the method may be practiced while the roller is actually mounted on the finishing device; however, there is no requirement of this.

It is foreseen that in a typical convenient application, for replacement of brush segments on industrial cylindrical hub finishing devices, application will be as follows. First, if a slotted hub substantial identical to the one on the finishing device itself is available, then the unused, unmounted, hub can be utilized as a mold for preparing the brush segment. The brush segment can then be removed from the hub, and applied on the mounted hub. In the alternative, if a second hub for the finishing device is available, even though it may not be identical to the first hub, the unmounted hub can be utilized for the molding process, and then once it is completely loaded with brush segments it can be mounted in the cylindrical hub finishing device, replacing the hub thereon. If the only hub available for molding is the hub also utilized for operation of the device, then some down time may be necessary while the hub is removed and utilized in the molding operation.

In a typical molding operation, as described herein, a brush segment with a pliable substrate is positioned on the hub. The combination is then put through a setting or curing cycle. In some instances this may involve putting the combination of hub and brush segment in an oven for a period of time. After cure or set, and appropriate cooling, the brush segment is available for use as desired. For example, the brush segment may be removed from the molding hub, and mounted on a hub for use.

Preferably the brush segment practiced with the latter described methods include: a pliable substrate with first and second opposite surfaces; a carpet of bristles secured to the substrate to extend outwardly from the substrate first surface; and, a root system extending outwardly from the substrate second surface, the root system being appropriate for mounting to the slotted hub support structure, for example the cylindrical roller. The pliable substrate may be provided in a number of manners, including as a thermoplastic material or thermosetting material. If a thermoplastic material is utilized then generally the method comprises providing the substrate in a pliable form, i.e. a hot form, on the slotted hub support structure; and, the step of hardening comprises cooling the pliable substrate to a rigid state. If the substrate is formed from a thermosetting material then generally the method comprises either: (1) providing the pliable substrate in a form not completely thermoset, with the step of hardening comprising thermosetting the substrate to a rigid state; or (2) if the thermosetting material, after cure, is thermoplastic, it may (after cure) be heated to a softening point and molded, as described above.

Herein the term "thermoplastic material" is meant to refer generally to materials which exhibit softening upon heating, as described. The term is meant to include within its scope resin materials which have been thermoset, provided those materials exhibit thermoplastic properties as defined.

The invention includes within its scope structures made according to the methods described herein.

The drawings constitute a part of this specification and include exemplary embodiments of the present invention. It will be understood that in some instances relative material thicknesses and component sizes may be shown exaggerated, to facilitate an understanding of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a fragmentary environmental perspective view of a slotted hub cylinder/brush arrangement combination according to the present invention.

FIG. **2** is an enlarged end elevational view of a slotted hub cylinder/brush arrangement combination according to the present invention, with a portion of the arrangement shown in cross-section.

FIG. **3** is an enlarged, fragmentary, bottom perspective view of a brush/substrate arrangement according to the present invention.

FIG. **4** is a cross-sectional view of a segment of brush-/substrate according to the present invention, usable for engagement with a conventional slotted hub or the like, FIG. **4** being taken generally along line **4—4**, FIG. **3**.

FIG. **5** is a fragmentary exploded view showing a brush/substrate arrangement according to an alternate embodiment of the present invention, in cooperation with a hub shown in phantom lines.

FIG. **6** is a schematic perspective view of a cylinder/-brush arrangement combination illustrating an application of the present invention.

FIG. **7** is a schematic perspective view generally analogous to that shown in FIG. **6**, but illustrating a different arrangement of brush/substrate segments.

FIG. **8** is schematic perspective view generally analogous to that of FIGS. **6** and **7**, but showing yet another alternate arrangement of brush/substrate segments according to the present invention.

FIG. 9 is a schematic perspective view generally analogous to FIGS. 6, 7 and 8, but showing yet another alternate application of the principles of the present invention.

FIG. 10 is a cross-sectional view generally analogous to FIG. 3, but showing an alternate embodiment of a brush/substrate arrangement according to the present invention.

FIG. 11 is a cross-sectional view generally analogous to FIG. 4, but showing an alternate embodiment of a brush/substrate according to the present invention.

FIG. 12 is a cross-sectional view generally analogous to FIGS. 4 and 11, but showing an alternate embodiment of a brush/substrate arrangement according to the present invention.

FIG. 13 is a fragmentary end elevational view of a cylinder/brush arrangement combination according to the present invention; FIG. 13 illustrating an alternate embodiment of a brush/substrate arrangement according to the present invention.

FIG. 14 is a partially exploded, fragmentary, top plan view of a vibrating table having a brush/substrate arrangement according to the present invention in association therewith.

FIG. 15 is an end elevational view of the arrangement shown in FIG. 14.

FIG. 16 is a fragmentary cross-section of view taken generally along line 16—16, FIG. 14.

FIG. 17 is a fragmentary perspective view of a brush segment according to an alternate embodiment of the present invention, depicted on a slotted hub support structure.

FIG. 18 is a cross-sectional view of the brush segment shown in FIG. 17, the hub being shown fragmentary and in phantom; the view being taken along line 18—18 of FIG. 17.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

As required, detailed embodiments of the present invention are disclosed herein: however, it is to be understood that the disclosed embodiments are merely exemplary of the invention which may be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but rather as a basis for the claims, and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure, system or manner.

The reference numeral 1, FIG. 1, generally illustrates an industrial cylinder brush finishing device modified according to the present invention. An "industrial" cylinder brush finishing device is a rotating cylinder device typically prepared for operation of rotation speeds of at least about 400 rpm. From the following descriptions, it will be understood that device 1 is generally conventional, except for the manner and arrangement by which brush material is applied to the cylinder hub. Specifically, device 1 comprises a slotted support structure comprising a horizontally mounted cylinder hub 3, mounted in a mechanical device 4 such that the hub 3 may be selectively rotated at a preferred speed. Arrangement 4 generally not only includes a drive mechanism 5 for hub 3, but also adjustment means (not detailed) for selective positioning of the hub 3, relative to a track or path of movement of articles, such as article 6, to be treated upon passage through the arrangement 4.

The cylindrical hub 3 depicted generally comprises a conventional hub, such as a 3M RX hub. The hub core may, for example, be: constructed from a single piece of extruded aluminum; or cast relatively from hard plastic, including casting from thermoplastic resins and casting from thermosetting resins. It may also be machined from steel or constructed from similarly rigid material. The hub 3 comprises an elongate cylinder member 7 having longitudinal slots therein. For the embodiment shown, there are about five slots for every inch outside diameter of the hub. For typical hubs, the longitudinal slots extend the complete length of hub 3, and thus each slot opens to opposite ends 8 and 9 of the hub 3. An end view of hub 3 is presented in FIG. 2, with a portion shown in cross-section.

Hub 3, FIGS. 1 and 2, forms part of a cylinder brush 10 which, FIG. 2, has a brush surface 11 formed from a plurality of bristles 12 mounted in a substrate arrangements 14. For the embodiment shown, bristles 12 are mounted independently, and spaced from one another, in substrate arrangement 14. That is, the bristles 12 form a Brushlon ®- carpet of bristles. An advantage to this, is that brush surface 11 comprises a dense, somewhat evenly spaced, carpet of bristles 12. Spaces between clumps, tufts or rows, of bristles are avoided to advantage.

Still referring to FIG. 1, arrangement 1 includes first and second opposite bearing/bushing arrangements 16 and 17 oriented to rotatively support hub 3 for rotation on longitudinal axle 18 about longitudinal axis 19. For typical systems, such as certain of those described above, a changing of the brush segments on a hub such as that shown in FIG. 1 would involve a dismounting of the hub from bushing/bearing arrangements 16 and 17, and in many instances from axle 18. Avoidance of such a cumbersome task of changing brush segments, and down time associated therewith, is in part one of the objectives of certain of the preferred embodiments of the present invention. This capability is not required, however, of all embodiments.

It is noted that a cylinder brush having a carpet of bristles has been obtained in the past, by utilizing, for example, a 3M Brushlon ® arrangement. Specifically, a flexible strip of Brushlon ® material has been helically wound about, and attached to, a hub. However, such an arrangement has generally involved a smooth hub, rather than a slotted hub, and a hook and loop attachment mechanism operating between the bristle/substrate combination and the hub itself. As previously explained, some problems with such conventional arrangements have concerned difficulties in mounting the helically wound substrate quickly, efficiently, and sufficiently accurately, in a preferred manner. Also, dismounting for service or change of bristle has been relatively slow. Further, selected, custom, bristle patterns are relatively hard to effect with such a system.

Referring to FIG. 1, a section 20 of hub 3 is shown not having brush material mounted thereon. A segment 21 of brush material suitable for mounting in section 20 is also depicted (fragmentary) in FIG. 1. The segment 21, having a design according to the present invention, is such that it can be readily mounted in section 20, and can be relatively easily removed therefrom for replacement, as selected.

The present invention generally comprises an arrangement and manner whereby brush surfaces such as surface 11 can be relatively easily mounted on a conventional roller hub, having longitudinal slots therein. The

result is an arrangement having a thick outer brush surface comprising a carpet of bristles, and the advantages associated therewith. Advantages over the conventional helically wound Brushlon ® method at least in part result from the fact that the segments are more easily mounted and dismounted. Other advantages will be apparent from further descriptions.

Referring to FIG. **2**, brush surface **11** is shown formed from a plurality of individual substrate segments **25** each having bristles **12** thereon. In particular, for the arrangement shown in FIG. **2**, the outer brush surface **11** is shown formed from four segments **25**, each of which extends through a 90° arc of the cylinder outer surface **26**. Thus, for the arrangement shown in FIGS. **1** and **2**, the outer brush surface **11** is formed from four elongate rows of segments corresponding to segment **21**.

Each brush segment **25** includes: a substrate portion **30**; a bristle portion **31**; and, a root arrangement **32**. For certain applications, the substrate portion **30** is a polymeric plastic substrate which exhibits some elasticity and which can be readily flexed into the arcuate manner shown. That is, for those applications preferably substrate **30** is relatively flexible. Certain advantages from this flexible nature of substrate portion **30** will be apparent from the following.

The bristle portion **31** includes bristles which may be formed from a variety of materials including: metallic wires; plastic coated wires; and, plastic filaments. Examples of metallic wires are: steel wires; beryllium copper wires; stainless steel wire; "Z" nickel wire; copper wire; brass wire; bronze wire; and, aluminum alloy wire. For plastic coated wires, the plastic coatings may include: nylon; vinyl plastics; trifluorochloroethylene polymer, neoprene and copolymers of butadiene and acrylonitrile. Examples of plastic filaments include nylon, polypropylene, polyethylene, and polyester materials. The bristle material may optionally have abrasive particles impregnated into the bristles. The preferred bristle material comprises plastic filaments with or without abrasive particles.

Means are generally provided for attachment of the bristles **12** to the substrate portion **30**. For the embodiment shown in FIG. **2**, this means comprises a layer of polymeric resin material **33**. It will be understood, however, that in some arrangements the attachment means may comprise part of the substrate portion **30** itself. That is, the bristles **12** could be imbedded directly into the substrate portion **30**.

The root arrangement **32** may be integral (unitary) with the substrate portion **30**, or it may be attached thereto by a variety of means. For the embodiment shown, the root arrangement **32** comprises extensions formed integrally (unitary) with the substrate portion **30**.

One of segments **25** is depicted in FIGS. **1**, **3** and **4**. The segment **25** comprises an elongate flat rectangular substrate portion **40** having a pair of spaced elongate longitudinal roots **42** extending longitudinally therealong. On a side **43** of substrate **40** opposite roots **42**, a bristle portion **45** comprising a bed or carpet of bristles **46** embedded in a resin system **47** is provided. The bristles **46** are individually retained (similarly to a 3M Brushlon ® product). That is, for the embodiment shown in FIGS. **1** and **3**, they are not formed in tufts and they are not formed in crimped channels or rows. The bed of bristles **46** is substantially continuous.

Preferably the substrate **40** is formed from a flexible polymeric material, such as a polyamide, polyether or acrylonitrile/butadiene/styrene copolymer. A variety of resins may be utilized to hold the bristles **46** in position. Preferably the resin system **47** is such as will be flexible, along with substrate **43**. As previously indicated a variety of constructions of individual bristles and bristle materials may be utilized, the arrangement shown in FIGS. **1**, **3** and **4** merely providing an example.

Roots **42** each include a narrow neck **50** and a relatively wide head **51**. Referring to FIG. **2**, the wide heads **51** are sufficiently sized so as to be capable of secure retention within the longitudinal channels **55** of hub **3**. More specifically, FIG. **2**, each channel **55** includes a relatively wide, deep, portion **57** and a relatively narrow neck portion **58**. If roots **50** are slid longitudinally into the slots, the wide head portions **51** of the roots **42** will be radially secured or anchored within wide channel portions **57**, due to interference with the narrow neck portions **58**. Referring to FIG. **1**, mounting of a segment **25** or **21** will be understood as occuring by longitudinal engagement with slotted hub **3**, in the manner illustrated. Utilization of a somewhat flexible substrate **40** and resin system **47**, permits curving or bending of the segment **25** (or **21**) to accommodate curvature of the hub **3**.

Referring to FIGS. **1** and **2**, preferably each substrate, such as substrate **40**, is sized to extend, when mounted on the hub **3**, over an arcuate extension of at least about 6° preferably 30° to 180°, and most preferably no greater than about 120°. For the embodiment illustrated in FIGS. **1** and **3**, the size of each substrate is appropriate for an arcuate extension of about 90°. As a result of this size of extension, FIG. **1**, the substrates can be mounted or dismounted, longitudinally with respect to the slots **9**, without the hub **3** being dismounted from arrangement **1**. That is, due to the relatively small arcuate extension of the substrates, they can be passed over bearing/bushing arrangements **16** and **17** during mounting/dismounting. This is highly advantageous, and leads to a system in which replacement of segments can take place without dismounting from the apparatus **1**.

Referring to FIG. **4**, for the embodiment shown each substrate **40** may include a plurality of roots, for the specific embodiment shown two roots, **42** thereon. The two roots **42** shown are spaced apart for receipt in the first and fifth of a set of five longitudinal slots, FIG. **2**. It will be understood that advantages from using a flexible, elastic, flat substrate **40** result. First, along edges **61** and **62**, of adjacent substrates **30**, tight, snug, engagement with hub **3** will result. Further, a relatively small gap between adjacent bristles will occur.

Referring to FIGS. **3**, **11** and **12**, for arrangements involving a plurality of roots, for example arrangements including two roots as shown in these figures, preferably the end roots are spaced from opposite side edges of the arrangement. Referring to FIG. **3**, for example, preferably each root **42** is spaced apart from its associated side edge **42***a* by region **42***b* of substrate **40**. Region **42***b* will ensure that when the arrangement is mounted in a slotted hub, FIG. **2**, no two roots are immediately adjacent one another, competing for the same slot. A preferred distance of extension for region **42***b*, between edge **42***a* and root **42**, is about one-half the distance between adjacent slots in a slotted hub arrangement. A preferred distance is at least about 0.5 to 0.6 centimeters. Other advantages which result from this extension in-

clude facilitation of a snug fit between adjacent substrate on a hub, FIG. **2**, convenience of manufacture and ease of mounting/handling.

Still referring to FIG. **2**, it will be understood that for an arrangement in which the bristles **12** extend outwardly generally perpendicularly from the substrate **30** (perpendicular to a tangent for a curved substrate) along edges **61** and **62** a gap of substantial size between adjacent substrates will be magnified or increased, as the outer ends of the bristles are approached. In general, in order to maintain a substantially continuous brushing surface **11**, it is desirable to maintain the gap between adjacent side edges **61** and **62** of substrates **30** at a relative minimum. Preferably they abut. In some applications, maintenance of a relatively small gap between adjacent bristles can be facilitated through utilization of bristles along side edges **61** and **62** which are not substantially perpendicular with respect to the substrate **30**.

A variety of root systems may be developed, including ones having specific shapes different from those shown. In addition, variations in the shapes of slots for hub arrangements may be utilized, for engagement by root systems according to the invention. What is generally required, is a combination of a longitudinal slot and a root design such as to provide for the function of secure anchoring or engagement.

Several alternate root designs are shown in the alternate embodiments illustrated in FIGS. **11** and **12**. Referring to FIG. **11**, the segment **63** shown includes teardrop-shaped root member **64**. For the alternate embodiment of FIG. **12**, the brush segment **65** includes a root member **66** having a diamond-shaped head portion **67**. It is noted that for the embodiments of FIGS. **11** and **12**, the brush bristles **68** and **69** respectively are shown mounted by direct embedding into the substrate, i.e. with no resin layer therebetween.

For the embodiment of FIGS. **1–4**, the substrate has been described as flat, flexible and elastic, as shown in FIGS. **3** and **4**, and as applied in FIGS. **1** and **2**. The arrangements have been described as having a root system comprising first and second spaced roots, generally adjacent, but spaced inwardly from, opposite side edges **61** and **62** of the segment **25**. Further, the individual roots **42** have been described and shown as being substantially continuous, and extending along the complete length of the associated segment **25**, FIG. **3**.

It will be understood that a variety of alternate arrangements may be provided. For example, not only may different shaped roots be used, but also: roots which do not extend continuously along the complete length of the substrate may be used; a number other than two roots may be utilized; the roots may be spaced differently than shown for the preferred embodiment; the roots may be reinforced by embedded structural material such as metal pieces, composite material, or the like; and, the roots need not be formed integral, or unitary, with the substrate **30**. However, the arrangement depicted is advantageous, for convenience in certain applications.

It is noted that for the embodiments shown or described in FIGS. **1**, **2**, **3**, **4**, **11** and **12**, i.e. multi-root arrangements, means are automatically provided to inhibit any rocking, tipping or flapping of the substrate relative to the circular, cylindrical, hub. That is, an initial secure mounting is ensured. This means comprises the two, spaced, roots which ensure anchoring without rocking. More specifically, anchoring at least two positions, in connection with a rigid, elastic, substrate ensures tight, non-rocking mounting when the system is initially constructed.

A particularly advantageous, alternate, embodiment is illustrated in FIG. **5**. In FIG. **5** a segment **70** according to the alternate embodiment is depicted in cross-section; and, it is illustrated in exploded view with respect to a hub **71**, analogous to hub **3**, shown in phantom lines. Segment **70** includes: a substrate **75**; a root arrangement **76**; a resin system **77**; and, a bed **78** of bristles **79**. The bed **78** of bristles **79**, and resin system **77**, may be substantially analogous to those previously described, for the embodiment illustrated in FIGS. **1–4**. In the alternative, the bristles **79** could be mounted directly in the substrate **75**.

Two unique characteristics generally distinguish the embodiment specifically depicted in FIG. **5** from the embodiments of FIGS. **1–4** and **11** and **12**. These concern: the shape of substrate **75**; and, the nature of root system **76**. More specifically, substrate **75** has a curved configuration, i.e. is a curved extension, rather than a flat configuration like the embodiment of FIGS. **1–4**. Root arrangement **76** comprises a single, centrally located, root member **83**.

For some applications, advantages can be obtained from the arrangement of FIG. **5**. A substrate **75** having a single root member **83**, for example, will typically encounter less friction in the longitudinal channel, during mounting, than will a substrate having two elongate root members thereon. Also, a system having a relatively rigid, curved, substrate is less likely to distort, in use, than a system involving a flexible substrate.

It will be apparent that with a single centrally located root member **83**, a curved substrate **75** is necessary, in order to provide conformation of the substrate **75** to the curved outer surface **85** of the cylindrical hub **71**. Preferably, and as illustrated in FIG. **5**, substrate **75** is formed from a relatively rigid, but somewhat elastic, plastic or polymeric material having a concave side with a radius of curvature slightly smaller than the radius of curvature of the outer surface **85** of the hub **71**. As shown in FIG. **5**, when engagement between the segment **70** and hub **71** occurs, under such circumstances, relatively rigid substrate **75** will be forced to flatten out or spread out somewhat; and, due to its rigid, elastic, character, it will tightly press against the hub **71**. This will provide a relatively snug engagement between the substrate **75** and the hub **71**, and inhibit any tipping, flapping or rocking propensity that might otherwise occur for a segment **70** on a single, central, root member **83**. Thus, an anti-flap arrangement or means is provided in the segment of the embodiment of FIG. **5**, through use of a curved substrate, with a radius of curvature less than the support, in combination with a rigid, elastic, substrate material. This also helps ensure close association between adjacent segments **70** on a hub **71**. Such a system may also be utilized to advantage with an arrangement involving more than one root member.

An arrangement involving a relatively rigid substrate having a radius and curvature slightly smaller than the radius and curvature of the supporter hub, offers numerous advantages, including those mentioned above. Industrial cylinder brush systems, such as those described above and in reference to FIG. **1**, place substantial stress on brush segments during use. This stress has a tendency to promote deformation of adjacent brush segments, with respect to one another. A tight, snug mounting and connectivity between each brush segment and the hub will tend to resist this deformation,

and extend lifetime. An arrangement involving a substrate curvature no greater than, and preferably at least slightly less than, the curvature of the hub will facilitate this connectivity considerably.

The above described brush segment arrangements offer unique advantages over prior brush designs. First, and as illustrated in FIG. **1**, segments can be easily mounted, removed and replaced, as necessary. It will be understood, by examination of FIG. **1**, that mounting and dismounting can generally be accomplished without removal of the hub **3** from the finishing apparatus **1**. Unlike with a helically wound system, changing is relatively rapid and proper alignment between adjacent segments is relatively easily effected.

In application, mounting arrangements according to the present invention provide for a variety of possible arrangements. For example, FIG. **3**, the brush surface **11** shown generally comprises four elongate strips or segments which extend completely longitudinally across the hub **3**. It will be understood that there is, of course, no requirement that all four segments of brush material be identical. That is, different brush bristle constructions, density etc. can be used, for the different strips.

Some useful variations in loading onto hubs are illustrated in FIGS. **6**, **7**, **8** and **9**. In FIG. **6**, for example, a hub **90** is shown having a plurality of sections or segments **91** of brush material mounted thereon. The individual sections or segments **91** do not extend completely longitudinally across hub **90**. Thus, the overall cylinder brush **93** may be provided with a varying lateral construction. That is, different brush materials can be used in a row across the hub. The arrangement shown in FIG. **6** is "bricked"; that is, segment ends of adjacent rows do not align directly with one another, but rather they are offset. This arrangement would generally avoid the presence of small gaps between longitudinally adjacent brush segments extending completely around cylinder brush **93**, at any given location.

The arrangement shown in FIG. **7** also illustrates that a plurality of segments may be utilized to provide an overall cylinder brush **100**. Different bristle constructions including: variations in bristle lengths; variations in bristle abrasiveness; and, variations in bristle density, can be utilized in different segments, to advantage. For example, different surface effects on material being treated, or different effects in different areas of those materials being treated, can be obtained.

In FIG. **8** an arrangement **110** is illustrated which shows that gaps **111** can be left between sections **112** of brush segments. Thus, for example, the surface of an article can be treated at only selected places, through selected location of such gaps **111**.

It will be understood that in some applications, it may be desired to provide anchors or the like mountable in association with the longitudinal channels, to facilitate construction of an arrangement such as that shown in FIG. **8**. The anchors can be used as stays, along ends of various individual segments **113**, to prevent unintended longitudinal sliding of the segments **113** with respect to the hub **115**. Further, for any of the embodiments, the hub **115** can be provided with stays or flanges on opposite ends, to prevent unintended longitudinal movement of segments mounted therein. No detail is provided with respect to anchors or stays in the longitudinal channels, or in association with the hubs, since any of a variety of arrangements could be utilized, and no specific arrangement is intended to be noted. Generally what would be operable would be an arrangement capable of being secured to the hub in a manner avoiding interference with brush activity, but which aligns with ends of brush segments inhibiting longitudinal sliding thereof.

The arrangement **120** illustrated in FIG. **9** demonstrates that arrangements can be developed in which bristle sizes of various lengths can be provided in different portions of the arrangement. Such an arrangement could be used, for example, to treat a surface having troughs therein. An advantage to the present invention is that such custom arrangements can be easily and quickly provided, without substantial expense.

From FIGS. **6**, **7**, **8** and **9** it will understood that a wide variety of arrangements may be easily and readily provided through utilization of brush segments according to the present invention. Thus, through provision of a plurality of sets of brush segments, an operator of a finishing operation can readily change or modify existing cylindrical hubs, to accommodate a very wide variety of possible finishing operations. The examples illustrated in FIGS. **1**, **6**, **7**, **8** and **9** are intended to be merely representational of possibilities, and not limiting.

Another unique embodiment is illustrated in FIG. **10**. FIG. **10** generally depicts a cross-sectional view analogous to that of FIG. **4**, but of an arrangement **140** having bristles **141** extending outwardly at an angle, rather than perpendicular to the substrate. The arrangement **140** otherwise includes: a resin system **142**; a flat, flexible, elastic substrate **143**; and, a root arrangement **144**.

It will be understood from reference to FIG. **10**, that the arrangement **140** therein depicted can be mounted in the hub of a system such as that shown in FIG. **1** with the bristles **141** pointed generally toward the direction of rotation, or opposite to the direction of rotation. This can be utilized to achieve different finishing effects. Further, the very same arrangement **140** can be reversed after some use, to accomplish a different finishing effect. Therefore, an intent with respect to FIG. **10**, is to depict that brush segments according to the present invention can be reversed after a period of use, if desired, for example to even wearing or achieve different finishing effects. Reversing would be possible for any of the embodiments shown; however unique advantages are obtained with an arrangement (FIG. **10**) that is asymmetric with respect to reversal.

Another purpose of the arrangement shown in FIG. **10**, is to suggest use in arrangements other than circular, cylindrical hub, arrangements. That is, a variety of slotted support structures other than hubs may be used. In conventional arrangements, angularly directed bristles **141** have been utilized with a flat, vibrating, surfaces. Articles to be treated are set on the vibrating surface and, as a result of the vibration, generally move in the direction toward which the bristles extend. During movement along the vibrating surface of the bristles, the effect of the bristles is to provide surface finishing of the articles. That is, the articles move on more or less stationary, but vibrating, brush segments. It will be understood that segments according to the present invention may be mounted in association with vibrating systems, if the vibrating systems are provided with appropriate mounting slots. Thus, for example, an industrial finishing operation which uses equipment with circular hubs and also equipment with flat, vibrating, finishing systems, may be able to utilize the same brush segments for both operations, if segments analogous to those illustrated in FIG. **2** are made; and, if both the hub

equipment and the vibrating table equipment are appropriately adapted for mounting of the root system.

With respect to vibrating tables, attention is directed to the embodiments of FIGS. **14**, **15** and **16**. In FIG. **14** a top plan view of a vibrating table arrangement **150** is shown. The vibrating table includes a pair of elongate longitudinal slots **151** extending therealong. An extension of segment **155** is shown partially mounted in the longitudinal slots **151**. It is noted that transverse slots, rather than longitudinal slots, may be used to advantage in some arrangements.

In FIG. **15** an end elevational arrangement is shown in FIG. **14** as depicted. The table **150** is shown with segment **155** partially mounted therein. Segment **155** is depicted including a substrate **156** a root arrangement **157** and bristles **158**.

Referring to FIG. **16**, segment **155** is shown in cross-section and bristles **158** are shown leaning in the general direction indicated by arrow **160**. It will be understood as arrangement **150** is vibrated, articles resting on bristles **158** will generally move in the direction of arrow **160**.

Referring to FIG. **13**, an alternate root system is depicted. In particular, in FIG. **13** a brush segment **200** is shown mounted upon a hub **201**. The brush segment **200** includes a substrate **205** having bristles **206** thereon. Segment **200** also includes a root arrangement **210**, comprising a pair of root members **211**. Each root member **211** includes an elongate sleeve **212** that is attached to, and depends from, a bottom side **215** of substrate **205**. Sleeves **212** are expanded by means of rods or slides **220** positioned therein, to form a head portion **225** in each root member **211** and **212**.

In an alternate embodiment, not shown, brush segments according to the present invention could be mounted along the inside of a rotating hub, to brush items tumbled therein. From this it will be understood that a wide variety of support structures may be utilized in association with brush segments according to the present invention.

Improvements in, and Modifications to, Previously Described Embodiments to the Present Invention

In application of the principles discussed herein above, it has been found that commercial industrial slotted hub cylindrical brush arrangements pose one previously unforeseen problem. The commercially used hub arrangements have not, in the past, been constructed with uniformity of distance between slots, and/or radius of curvature in all systems. That is, there are noted variations in distances between slots on different hubs, and also variations in distances between slots on the same hub. Also, the curvature of the hub outer surfaces have varied. For general system-wide utility of the principles of the present invention, some problems have resulted from this lack of uniformity.

To address these concerns, there has been developed a specific method and arrangement for the preparation of brush arrangements in a preferred manner. One such preferred arrangement **330** is illustrated in perspective in FIG. **17**, and in cross-section in FIG. **18**.

Referring to FIGS. **17** and **18**, the arrangement **330** includes a substrate **340** including a plurality of roots, for the specific embodiment shown two roots **342**, thereon. The two roots **342** are shown spaced apart for receipt in spaced apart longitudinal slots of a slotted hub mounting arrangement, such as the hub illustrated in FIG. **2**. In FIG. **17**, an analogous hub is shown. In FIG. **18**, a portion of the hub is depicted in phantom. The two roots **342** are also shown spaced apart from side edges **342***a*, by substrate extensions **342***b*. Extensions **342***b* have a width, i.e. distance between roots **342** and corresponding side edges **342***a* generally corresponding to approximately one-half the distance between adjacent slot in a cylinder hub to which the arrangement is to be mounted. Preferably, the distance of that width is about 0.5 to 0.6 cm.

As with previously described embodiments, preferably the arcuate extension of substrate **340** is at least about 6° preferably 30° to 180°, and most preferably no greater than 120° on a cylinder hub. Most preferably, it is about 90°. The arrangement of FIGS. **17** and **18** includes a plurality of bristles **350** thereon, mounted in position by means of resin **351**.

Preferably, the construction illustrated in FIGS. **17** and **18** is, in part, formed when mounted on a slotted support structure such as a hub comprising or corresponding to the one on which it is to be mounted for use. Preferably, the arrangement is initially prepared with the substrate selectively pliable (moldable) to conform to a specific hub. The brush segment is then placed in the hub and the material is fully hardened. The material utilized for the substrate can be either thermoplastic or thermosetting; and, use of either thermoplastic or thermosetting properties may be made. If a thermoplastic arrangement is utilized, then generally the brush segment is heated to flexibility (softening or pliability), and then put on the slotted support structure (hub) and cooled to rigidity. If the arrangement is thermosetting, then in some applications the partially cured (but still pliable) arrangement is placed on a slotted support structure (hub) for fit, and then is heated, for example while on the hub, to cure. The relatively rigid arrangement which results from either method, would of course have a radius of curvature very closely conforming to the slotted support structure (hub). In addition, it will have been customized to the slotted support structure (hub) arrangement. The slotted support may, of course, be a construction other than a cylindrical hub. It is noted that in some applications the substrate may be formed from a thermoset material which, after setting the rigidity, exhibits appropriate thermoplastic characteristics, i.e. softens upon exposure to heat. Such materials may also be utilized in substrates according to the present invention, and will be referred to herein as "thermoplastic", since it is the thermoplastic nature of the cured material which is utilized for the molding process of the present invention.

An example of a method of construction is as follows. A thermoplastic substrate is prepared, with bristle segments thereon as generally described above. The brush segment is (for example) prepared with a substrate curvature corresponding to a six-inch diameter hub with slots spaced about five inches apart. It is desired to change the brush segment for use on an eight-inch diameter hub, with slots spaced about five inches apart. The brush segment, with a thermoplastic resin as the substrate, is heated to flexibility and is then placed on a warm (for example, 225° F. or 107° C.) hub, of eight-inch diameter. The segment/hub combination is then cooled and the segment substrate hardened. The result is that the brush segment radius of curvature conforms to the eight-inch diameter hub. An example of a resin that may be utilized in the substrate of such a system is the Royalcast ® 315 system available from Uniroyal Chemical Company, Inc., Naugatuck, Conn. 06770.

Preferably, the resin used has a softening point of no less than about 70° C. Also, preferably it does appreciably soften at a convenient temperature, for example within the range of 90° C. to 150° C.

It will be understood that the method of manufacture described immediately above allows preparation of arrangements for use in industries wherein no specific uniform hub design is provided. Especially if the thermoplastic arrangement is utilized for the substrate, initially manufactured arrangements can be molded, specifically, to each hub in a preferred manner. The result in the end will be a relatively rigid arrangement, rather than a flexible substrate arrangement, leading to advantages as discussed above with respect to inhibition of deformation from industrial application of the brush segments. That is, the relatively rigid substrates, after setting of the resin in the substrate, will resist deformation during utilization of the cylindrical brush. On the other hand, if relatively flexible substrate arrangements such as those described with respect to FIG. 3 above were utilized, the probability of deformation in use would be higher.

In the following experimental example a description is provided of the specific preparation of a substrate arrangement according to the general description provided above for the improved system.

From the above, it will be understood that the mounting system according to the present invention provides for a unique versatility not previously readily obtainable. Custom designed brushes can be easily accomplished, through variations in segments. Segments can be easily dismounted and cleaned if necessary. Further, worn out segments can be readily replaced. Mounting does not, in general, require extreme precision. Further, mounting of brush segments can be effected in many instances without a dismounting of the hub from the finishing apparatus, FIG. 1.

It is to be understood that while certain embodiments to the present invention have been illustrated and described, the invention is not to be limited to specific forms, arrangement of parts, or methods herein described and shown.

EXPERIMENTAL DESCRIPTION

A brush segment was made according to the following procedure. A mold was heated to 100° C. to remove any significant moisture content. The mold was essentially the inverse of the brush segment illustrated in FIG. 3 above. The mold was then sprayed with a mold release.

In a separate operation, a Royalcast ® 3105 part A resin, obtained from Uniroyal Chemical Company, Inc., Naugatuck, Conn., was subjected to vacuum, for removal of trapped air bubbles. The part A resin was mixed in a 100 to 29 weight ratio with curative. The curative consisted of, by weight, 42.8% Royalcast ® 3101 part B curative, 52.3% Royalcast ® 3101 part B-60 curative, both available from Uniroyal Chemical Company, Inc., Naugatuck, Conn., 3.8% black dye add 1.2% ortho diethylbisaniline (gelation agent).

The resin/curative mixture was placed into the heated mold. A plurality of nylon brush fibers were placed in the liquid resin/curative mixture. The brush fibers were 2.54 cm in length and had a diameter of about 0.3 millimeters. The mold and resin/fiber composite was placed in an oven for 10 minutes at 38° C., 10 minutes at 150° C. and 10 minutes at 120° C. The brush segment was then cooled in the mold at room temperature for 15 minutes, and the brush segment was removed from the mold. Any flash on the brush segment was then removed.

The partially cured brush segment was placed on a rack in an oven at 100° C. for 30 minutes, to make the brush segment pliable. The warmed brush segment was removed from the oven, flexed into the desired shape and mounted in the appropriate size slotted support structure. The slotted support structure having the brush segment thereon was placed in an oven at 100° C. for 16 hours. Following this heat treatment, the slotted support structure with the brush segment was cooled and the brush segment was removed from the slotted support structure.

In general, the Royalcast ® 3105 system is a system of castable thermoset plastics. Part A is a liquid having a viscosity at 68° F. (20° C.) of 8 Poise, and a specific gravity at 68° F. (20° C.) of 1.123.

Royalcast ® 3101 part B has a viscosity at 68° F. (20° C.) of 13 Poise, and a specific gravity at 68° F. (20° C.) of 1.075. Royalcast ® 3101 part B-60 exhibits similar properties to 3101 part B.

The mold temperature for the Royalcast ® system is reported by the manufacturer as being 100° C. Mold shrinkage is reported as about 1%.

What is claimed and desired to be secured by Letters Patent is as follows:

1. A finishing wheel brush segment for mounting on a cylindrical slotted hub support structure of an industrial cylinder brush finishing device; said brush segment comprising:

(a) a substrate having first and second opposite surfaces and first and second spaced side edges;

(i) said substrate consisting essentially of material: which retains its configuration at temperatures up to at least 70° C.; and, which will become sufficiently soft when heated to a softening temperature within the range of 90°–150° C. to be molded to a selected configuration that is curved in cross-section and has an elongate convex side and opposite concave side, the concave side corresponding to the substrate second surface and defining an arc of extension between said first and second side edges of between about 30° and 180°,;

(ii) said substrate further consisting essentially of material which, upon being molded to a selected configuration when heated to a softening temperature within the range of 90°–150° C., will retain the selected configuration when cooled and retained at temperatures below 70° C.; and,

(iii) said substrate further consisting essentially of material which will maintain its structural integrity when said brush segment is mounted on a rotating cylinder of an industrial cylinder brush finishing device and is applied to finish a work piece at rotational speeds of at least 400 rpm;

(b) a carpet of bristles secured to said substrate to extend outwardly from said substrate first surface; and,

(c) a root system extending outwardly from said substrate second surface; said root system being constructed and arranged to mount said substrate to the slotted support structure by engagement with at least one slot thereof and to retain the substrate on the slotted hub support structure when the finishing device is in operation; said root system comprising at least one elongate root member, each

root member extending generally parallel to, and being spaced by at least about 0.5 cm from, said substrate first and second side edges.

2. A brush segment according to claim **1** wherein said root system includes a plurality of spaced, elongate, substantially parallel root members.

3. A brush segment according to claim **1** wherein said root system is unitary with said substrate.

4. A brush segment according to claim **1** wherein said root system comprises two spaced, elongate, substantially parallel, root members.

5. A brush segment according to claim **1** wherein each bristle, of said carpet of bristles, extends generally perpendicularly to a plane of a surface of said substrate whereat said each bristle is mounted.

6. A finishing wheel brush segment for mounting on a cylindrical slotted hub support structure of an industrial cylinder brush finishing device; said brush segment comprising:

(a) a substrate having first and second opposite surfaces and first and second spaced side edges;

(i) said substrate being constructed and arranged to retain its configuration at temperatures up to at least 70° C.; and, to become sufficiently soft when heated to a softening temperature within the range of 90°–150° C. to be molded to a selected configuration that is curved in cross-section and has an elongate convex side and opposite concave side, the concave side corresponding to the substrate second surface and defining an arc of extension between said first and second side edges of between about 30° and 180°;

(ii) said substrate further being constructed and arranged such that once having been molded to a selected configuration when heated to a softening temperature within the range of 90°–150° C., will retain the selected configuration when cooled and retained at temperatures below 70° C.; and,

(iii) said substrate further being constructed and arranged to maintain its structural integrity when said brush segment is mounted on a rotating cylinder of an industrial cylinder brush finishing device and is applied to finish a work piece at rotational speeds of at least 400 rpm;

(b) a carpet of bristles secured to said substrate to extend outwardly from said substrate first surface; and,

(c) a root system extending outwardly from said substrate second surface; said root system being constructed and arranged to mount said substrate to the slotted support structure by engagement with at least one slot thereof and to retain the substrate on the slotted hub support structure when the finishing device is in operation; said root system comprising at least one elongate root member, each root member extending generally parallel to, and being spaced by at least about 0.5 cm from, said substrate first and second side edges.

7. A brush segment according to claim **6** wherein said root system includes a plurality of spaced, elongate, substantially parallel root members.

8. A brush segment according to claim **6** wherein said root system is unitary with said substrate.

9. A brush segment according to claim **6** wherein said root system comprises two spaced, elongate, substantially parallel, root members.

10. A brush segment according to claim **6** wherein each bristle, of said carpet of bristles, extends generally perpendicularly to a plane of a surface of said substrate whereat said each bristle is mounted.

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